CLAIMS

What is claimed is:

1. A device for characterizing a target coating containing unknown metallic flakes comprising:

(i) means for positioning said device over said target coating;

(ii) means for producing one or more beams of light at one or more preset intensities;

(iii) means for imaging;

(iv) means for directing said beams of light towards a target portion of said target coating;

(v) means for directing a reflection of said target portion to a photosensitive surface located in said means for imaging to capture a target image of said portion;

(vi) means for measuring characteristics of said metallic flakes in said target image at said preset intensity;

(vii) means for correlating said characteristics of said unknown metallic flakes in said target image to stored characteristics of known metallic flakes at said preset intensity to identify one or more said known metal flakes that match said characteristics of said unknown metallic flakes; and

(viii) means for displaying said identified one or more known metal flakes that match said characteristics of said unknown metallic flakes.

2. The device of claim 1 wherein said means (i), (ii), (iii), (iv) and (v) are positioned in a housing wherein said means (iii) are located opposite of said means (i) and wherein a beam splitter comprising said means (iv) and (v) is positioned between said means (i) and (iii) and wherein said means (ii) are positioned adjacent to said beam splitter to direct said beams at an angle normal to said target portion.

3. The device of claim 1 wherein said means (ii) comprise means (viii) for collimating said one or more beams of light.

4. The device of claim 1 where said means (iii) comprise means (ix) for focusing said reflection of said target portion on said photosensitive surface.

5. The device of claim 1 wherein said means (iii) comprise an imaging device suitable for producing said target images as gray target images.

6. The device of claim 5 wherein a footprint of said gray target images produced by said imaging device range from about 0.01 millimeters square to about 25.0 millimeters square.

7. The device of claim 5 wherein said gray target images are digitized in ranges from 40,000 pixels to 16,000,000 pixels wherein each said pixel is capable of recognizing 16 to 65,536 levels of light intensities.

8. The device of claim 7 wherein each said pixel is capable of recognizing 256 levels of said light intensities.

9. The device of claim 1 wherein said means (iii) comprise an imaging device suitable for producing said target images as gray target images or as color target images.

10. The device of claim 9 wherein a footprint of said gray and color target images digitized by said imaging device range from about 0.01 millimeters square to about 25.0 millimeters square.

11. The device of claim 9 wherein said gray and color target images are digitized in ranges from 40,000 pixels to 16,000,000 pixels wherein each said pixel is capable of recognizing 16 to 65,536 levels of light intensities for each of three primary color channels.

12. The device of claim 5 or 9 wherein said means (vi) comprise:

(a) means for scanning said target images above threshold levels at said preset intensities;

(b) means for locating regions of pixels recognizable in said target images above said threshold levels and at said preset intensities; and

(c) means for recording number of preset sizes of regions of pixels recognizable above said threshold levels at said preset intensities.

13. The method of claim 12 wherein said preset sizes of said regions of pixels comprise small, medium, large, extra large zones, clusters of zones, or a combination thereof.

14. The device of claim 13 wherein said small zone ranges from about 49 to about 83 micrometers square, wherein said medium zone ranges from about 127 to about 239 micrometers square, wherein said large zone ranges from about 342 to about 576 micrometers square, wherein said extra large zone ranges from about 577 to about 122500 micrometers square, and

wherein said cluster zones range from about 49 micrometers square to about 122500 micrometers square.

15. The device of claim 1 wherein said means (vii) comprise:

(a) means for comparing said characteristic of said unknown metallic flakes of said preset size to said benchmark characteristic of said known metallic flakes of same preset size extracted from a benchmark coating on a first panel containing said known metal flakes to determine a feature distance for each said preset intensity;

(b) means for adding said feature distances for all said preset intensities to arrive at a sum of said feature distances for said preset size;

(c) means for multiplying said sum with a weight factor to calculate a weighted feature distance for said preset size;

(d) means for repeating said steps (a), (b) and (c) for all other said preset sizes to determine weighted feature distances for other said preset sizes;

(e) means for adding said weighted feature distances for said preset sizes to arrive at a final feature distance for said coating on said first panel;

(f) means for repeating said steps (a), (b), (c), (d) and (e) to determine said final feature distances from benchmark coatings on other panels;

(g) means for selecting shortest final feature distances from said final feature distances; and

(h) means for identifying said known flake or a blend of said known flakes from said benchmark coatings on said panels having said shortest final feature distances.

16. The device of claim 1 wherein said target coating is applied over surface of an automotive body.

17. A method for characterizing a target coating containing unknown metallic flakes comprising:

(i) directing one or more beams of light at a preset intensity towards a target portion of said target coating;

(ii) directing a reflection of said portion to a photosensitive surface to capture a target image of said target portion;

(iii) measuring characteristics of said unknown metallic flakes in said target image at said preset intensity;

(iv) correlating said characteristics of said unknown metallic flakes in said target image to stored characteristics of known metallic flakes at said preset intensity to identify one or more said known metal flakes that match said characteristics of said unknown metallic flakes; and

(v) displaying said identified one or more known metal flakes that match said characteristics of said unknown metallic flakes.

18. The method of claim 17 further comprising repeating said steps (i), (ii), and (iii) at other preset intensities.

19. The method of claim 17 or 18 further comprising repeating said steps (i), (ii), (iii) and (iv) at other target portions of said target coating.

20. The method of claim 17 wherein said target coating comprises polymers, pigments, and additives.

21. The method of claim 20 wherein said pigments comprise light absorbing pigments, light scattering pigments, light interference pigments, light reflecting pigments, or a combination thereof.

22. The method of claim 17 wherein said target coating is affixed to surface of an automotive body.

23. A method for characterizing a target coating containing unknown metallic flakes comprising:

(i) sequentially directing one or more beams of light at at least two preset intensities towards a target portion of said target coating;

(ii) directing a reflection of said portion to a photosensitive surface to sequentially capture target images of said target portion at said preset intensities;

(iii) sequentially measuring characteristics of said unknown metallic flakes in said target images;

(iv) correlating said characteristics of said unknown metallic flakes in said target images to benchmark characteristics of known metallic flakes at said preset intensities to identify one or more said known metal flakes that match said characteristics of said unknown metallic flakes; and

(v) displaying said identified one or more known metal flakes that match said characteristics of said unknown metallic flakes.

24. The method of claim 23 wherein said target images on said photosensitive surface are in gray scale.

25. The method of claim 23 wherein said beam is collimated.

26. The method of claim 23 wherein in said step (i) said beam is directed at an angle normal to said target portion.

27. The method of claim 23 wherein said photosensitive surface is a charged couple device sensor of an imaging device that captures said target image.

28. The method of claim 23 wherein said step (iii) comprises:

(a) scanning said target images at first of said preset intensities and at first of threshold levels;

(b) locating regions of pixels recognizable above said first threshold level in said target images at said first of said preset intensities;

(c) scanning said target images at said first of said preset intensities and at subsequent said threshold level;

(d) locating new regions of pixels recognizable above said subsequent threshold level in said target images at said first of preset intensities;

(e) locating coincident regions of pixels recognizable above said subsequent threshold level that incorporate said regions of pixels recognizable above said first threshold level located in said step (b);

(f) adding number of said new and coincident regions of pixels of preset sizes located in said steps (d) and (e) to record a final number of said preset sizes of regions of pixels recognizable above said threshold levels at said first of preset intensities; and

(h) repeating said steps (a), (b), (c), (d), (e), (f) and (g) at subsequent said preset intensities.

29. The method of claim 28 wherein said coincident regions comprise:

(i) single contiguous regions of pixels recognizable above said first threshold level that are enveloped within single regions of pixels recognizable above said subsequent threshold level; and

(ii) plurality of regions of pixels recognizable above said first threshold level that are merged within regions of pixels recognizable above said subsequent threshold level.

30. The method of claim 28 wherein said preset sizes of said regions of pixels comprise small, medium, large, extra large zones; clusters of zones or a combination thereof.

31. The method of claim 30 wherein said small zone ranges from about 49 to about 83 micrometers square, wherein said medium zone ranges from about 127 to about 239 micrometers square, wherein said large zone ranges from about 342 to about 576 micrometers square, wherein said extra large zone ranges from about 577 to about 122500 micrometers square, and wherein said cluster zones range from about 49 micrometers square to about 122500 micrometers square.

32. The method of claim 23 wherein said step (iv) comprises

(a) comparing said characteristic of said unknown metallic flakes of said preset size to said benchmark characteristic of said known metallic flakes of same preset size extracted from a benchmark coating on a first panel containing said known metal flakes to determine a feature distance for each said preset intensity;

(b) adding said feature distances for all said preset intensities to arrive at a sum of said feature distances for said preset size;

(c) multiplying said sum with a weight factor to calculate a weighted feature distance for said preset size;

(d) repeating said steps (a), (b) and (c) for all other said preset sizes to determine weighted feature distances for other said preset sizes;

(e) adding said weighted feature distances for said preset sizes to arrive at a final feature distance for said coating on said first panel;

(f) repeating said steps (a), (b), (c), (d) and (e) to determine said final feature distances from benchmark coatings on other panels;

(g) selecting shortest final feature distances from said final feature distances; and

(h) identifying said known flake or a blend of said known flakes from said benchmark coatings on said panels having said shortest final feature distances.

33. The method of claim 32 wherein said benchmark characteristics of said known metallic flakes in said benchmark coatings on said panels are ascertained by the steps comprising

(i) sequentially directing one or more beams of light at at least two said preset intensities towards a benchmark portion of benchmark said coating on said first panel;

(ii) directing a reflection of said benchmark portion of said benchmark coating on said first panel to a photosensitive surface to sequentially capture benchmark images of said benchmark portion of said benchmark coating on said first panel;

(iii) sequentially measuring said benchmark characteristics of said known metallic flakes in said images at said preset intensities; and

(iv) saving said benchmark characteristics of said known metallic flakes in said benchmark images in a database, in a CD-ROM, hard drive of a computer, or in a host computer in communication with a client computer.

34. The method of claim 32 wherein said step (iii) comprises:

(a) scanning said benchmark images at first of said preset intensities and at first of threshold levels;

(b) locating regions of pixels recognizable above said first threshold level in said benchmark images at said first of said preset intensities;

(c) scanning said benchmark images at said first of said preset intensities and at subsequent said threshold level;

(d) locating new regions of pixels recognizable above said subsequent threshold level in said benchmark images at said first of preset intensities;

(e) locating coincident regions of pixels recognizable above said subsequent threshold level that incorporate said regions of pixels recognizable above said first threshold level located in said step (b);

(f) adding number of said new and coincident regions of pixels of preset sizes located in said steps (d) and (e) to record a final number of said preset sizes of regions of pixels recognizable above said threshold levels at said first of preset intensities; and

(h) repeating said steps (a), (b), (c), (d), (e), (f) and (g) at subsequent said preset intensities.

35. The method of claim 34 wherein said coincident regions comprise:

(i) single contiguous regions of pixels recognizable above said first threshold level that are enveloped within single regions of pixels recognizable above said subsequent threshold level; and

(ii) plurality of regions of pixels recognizable above said first threshold level that are merged within regions of pixels recognizable above said subsequent threshold level.

36. The method of claim 34 wherein said preset sizes of said known metallic flakes comprise small, medium, large, extra large metallic flakes; clusters of metallic flakes or a combination thereof.

37. The method of claim 36 wherein size of said small flake ranges from about 49 to about 83 micrometers square, wherein size of said medium flake ranges from about 127 to about 239 micrometers square, wherein size of said large flake ranges from about 342 to about 576 micrometers square, wherein size of said extra flake ranges from about 577 to about 122500 micrometers square, and wherein size of said clusters range from about 49 micrometers square to about 122500 micrometers square.

38. The method of claim 34 wherein said benchmark coatings on said panels comprise polymers, pigments, and additives.

39. The method of claim 34 wherein said pigments comprise light absorbing pigments, light scattering pigments, light interference pigments, light reflecting pigments, or a combination thereof.

40. The method of claim 23 wherein said target coating comprises polymers, pigments, and additives.

41. The method of claim 40 wherein said pigments comprise light absorbing pigments, light scattering pigments, light interference pigments, light reflecting pigments, or a combination thereof.

42. The method of claim 23 wherein said present intensities are fixed at three illumination levels.

43. The method of claim 23 wherein said wherein said photosensitive surface is a charged couple device sensor of an imaging device that captures said target images in gray target images.

44. The method of claim 23 wherein said wherein said photosensitive surface is a charged couple device sensor of an imaging device that captures said target images in gray target images or in color target images.

45. The method of claim 44 wherein a footprint of said gray and said color target images captured by said imaging device range from about 0.01 millimeters square to about 25.0 millimeters square.

46. The method of claim 45 further comprising:

(i) transforming RGB data of said target color images into L,a,b data;

(ii) accessing from a color formula database one or more color formulas that match said L,a,b data;

(iii) displaying said color formulas on a screen of a computer; and

(vi) selecting a desired color formula from said color formulas.

47. The method of claim 46 further comprising displaying identification criteria of said color formulas on said screen.

48. The method of claim 47 wherein said identification criteria comprise one or more of a manufacturer's name, make, model, year of production, color name, paint code, cross reference information, intended use, VIN number, or spectrophotometric data of a vehicle or its color.

49. The method of claim 46 wherein said computer is a client computer in communication with a host computer.

50. The method of claim 49 wherein said target color images reside on said client computer and said color formula database resides on said host computer.

51. A method for characterizing a target coating containing unknown metallic flakes comprising:

(i) directing sequentially a collimated beam of light at three preset intensities upon a target portion of said target coating at a normal angle;

(ii) directing a reflection of said coated surface to a photosensitive surface to sequentially capture images in a gray scale of said target portion at said preset intensities at said three preset intensities;

(iii) sequentially measuring characteristics of said unknown metallic flakes in said target images;

(iv) correlating said characteristics of said unknown metallic flakes in said target images to benchmark characteristics of known metallic flakes at said preset intensities to identify three said known metal flakes that match said characteristics of said unknown metallic flakes;

(v) displaying said identified one or more known metal flakes that match said characteristics of said unknown metallic flakes.

52. A method for producing a metallic flake containing coating composition, wherein a coating therefrom matches characteristics of a target coating containing unknown metallic flakes, said method comprising:

(i) directing one or more beams of light at a preset intensity towards a target portion of said target coating;

(ii) directing a reflection of said portion to a photosensitive surface to capture a target image of said target portion;

(iii) measuring characteristics of said unknown metallic flakes in said target image at said preset intensity;

(iv) correlating said characteristics of said unknown metallic flakes in said target image to stored characteristics of known metallic flakes at said preset intensity to identify one or more said known metal flakes that match said characteristics of said unknown metallic flakes;

(v) displaying said identified one or more known metal flakes that match said characteristics of said unknown metallic flakes;

(vi) preparing one or more test coating compositions containing said identified known metal flakes;

(vii) applying said test coating compositions over test substrates to produce test coatings thereon;

(vii) comparing said test coatings against said target coating to select test coating having characteristics that match said characteristics of said target coating; and

(viii) selecting test coating composition that produces said matched test coating.